

AMENDMENTS TO THE CLAIMS

Listing of the claims:

Following is a listing of all claims in the present application, which listing supersedes all previously presented claims:

1. (Previously Presented) A solid-state image pickup device, comprising:
a semiconductor substrate having a two-dimensional plane on a surface thereof;
photoelectric converter elements formed in or on said two-dimensional plane in a matrix configuration having rows and columns, wherein (m*n) rows of said photoelectric converter elements form a set, where m and n are integers greater than one;
one vertical charge transfer channel region formed in said semiconductor substrate for each of the columns of said photoelectric converter elements, adjacent to said each column;
two charge transfer electrodes so disposed over said vertical charge transfer channel regions for each of the rows of said photoelectric converter elements as to intersect said vertical charge transfer channel regions;
an array of color filters above said photoelectric converter elements, said array including color filters of a plurality of colors arranged in a repeating pattern in the column direction, said repeating pattern comprising a unit of n rows, and said color filters being formed in a one-to-one correspondence with said photoelectric converter elements; and
a drive circuit capable of conducting a symmetric readout operation in each set of (m*n) rows of photoelectric converter elements, wherein rows read-out by said

symmetric readout operation are distributed with non-readout rows of equal interval in the column direction of said array,

said symmetric readout operation comprising:

a first readout operation for reading first electric charges from a first group of photoelectric converter element rows which have an asymmetric distribution with non-readout rows of unequal interval in the column direction into said vertical charge transfer channel regions;

a $j \times n$ -rows transfer operation for transferring the read-out first electric charges $j \times n$ rows after said first readout operation, where j is an integer greater than one; and

a second readout operation for reading second electric charges from a second group of photoelectric converter element rows which have an asymmetric distribution with non-readout rows of unequal interval in the column direction, at positions $j \times n$ rows downstream of the rows of said first read-out operation, into said vertical charge transfer channel regions, to respectively add the read-out second electric charges to the transferred first electric charges in said vertical charge transfer channel regions, each one of said read-out second electric charges being added to a respective one of said transferred first electric charges of a same color,

said first and second readout operations being capable of reading electric charges from two rows of one unit of photoelectric converter element rows.

2. (Previously Presented) The solid-state image pickup device according to claim 1, wherein:

said n is two;

said j is $m/2$; and

said symmetric readout operation reads two units per said set.

3. (Previously Presented) The solid-state image pickup device according to claim 2, wherein:

said m is four;

said symmetric readout operation reads every second unit;

said first readout operation reads a second row of a first unit and a first row of a second unit; and

said second readout operation reads a first row of said first unit and a second row of said second unit.

4. (Previously Presented) The solid-state image pickup device according to claim 1, wherein:

said n is three;

said m is six;

said symmetric readout operation reads three units per said set;

said drive circuit is capable of conducting after said second readout operation:

another $j \times n$ -rows transfer operation for transferring the added electric charges $j \times n$ rows; and

a third readout operation for reading third electric charges from a third group of photoelectric converter element rows which have an asymmetric distribution with respect to any one row of the group, at positions $j \times n$ rows downstream from the rows of

said second readout operation, into said vertical charge transfer channel regions, to respectively add the read-out third electric charges to the transferred added charges in said vertical charge transfer channel regions.

5. (Previously Presented) The solid-state image pickup device according to claim 4, wherein:

said three units read out by the symmetric readout operation are distributed every second unit;

said first readout operation reads mutually different rows of first, second, and third units; and

said first, second, and third readout operations read electric charge from a first row, a second row, and a third row of said first, second, and third units, respectively.

6. (Previously Presented) A method of controlling a solid-state image pickup device comprising a semiconductor substrate having a two-dimensional plane on a surface thereof, photoelectric converter elements arranged in a matrix configuration having rows and columns, and formed in said two-dimensional plane, one vertical charge transfer channel region formed in said semiconductor substrate for each of the columns of said photoelectric converter elements, adjacent to said each column, two charge transfer electrodes so disposed over said vertical charge transfer channel regions for each of the rows of said photoelectric converter elements as to intersect said vertical charge transfer channel regions, and array of color filters formed above said photoelectric converter elements in one-to-one correspondence to said photoelectric

converter elements, said array including color filters of a plurality of colors, and having repetitive units of layout along the column direction, each unit being composed of n rows, where n is an integer larger than one, said method comprising the steps of:

(a) enabling $(m \times n)$ rows of photoelectric converter elements as one set, where m is an integer greater than one, to read first electric charges from a first group of photoelectric converter element rows which have an asymmetric distribution with non-readout rows of unequal interval in the column direction into said vertical charge transfer channel regions;

(b) transferring the read-out first electric charges $j \times n$ rows, where n is an integer greater than one, after said readout step (a); and

(c) reading second electric charges from a second group of photoelectric converter element rows which have an asymmetric distribution with non-readout rows of unequal interval in the column direction, at positions $j \times n$ rows downstream from the rows of said readout step (a), into said vertical charge transfer channel regions, to respectively add the read-out first and transferred second electric charges of a same color to each other in said vertical charge transfer channel regions,

said first and second readout steps (a) and (c) being capable of reading electric charges from two rows of one unit of photoelectric converter element rows.

7. (Previously Presented) The method of controlling a solid-state image pickup device according to claim 6, wherein:

said n is two;

said j is $m/2$; and

said readout steps (a) and (c) read two units per said set.

8. (Previously Presented) The method of controlling a solid-state image pickup device according to claim 7, wherein:

said reading steps (a) and (c) read every second unit;

said reading step (a) reads a second row of a first unit and a first row of a second unit; and

said reading step (c) reads a first row of said first unit and a second row of said second unit.

9. (Previously Presented) The method of controlling a solid-state image pickup device according to claim 6, wherein:

said n is three;

said m is six; and

said method further comprising the steps of;

(d) transferring the added electric charges for jxn rows after said second reading step (c); and

(e) reading third electric charges from a third group of photoelectric converter element rows which have an asymmetric distribution with respect to any one row of the group, at positions jxn rows downstream from the rows of said reading step (c), to said vertical charge transfer channel regions, to respectively add the read-out third and transferred added electric charges of a same color to each other in said vertical charge transfer channel regions.

10. (Previously Presented) The method of controlling a solid-state image pickup device according to claim 9, wherein:

said reading step (a) reads mutually different rows of first, second, and third units at every second unit; and

said steps (a), (c), and (e) read electric charges from a first row, a second row, and a third row of said first, second, and third units, respectively.

11. (Previously Presented) A solid-state image pickup device, comprising:

a semiconductor substrate having a two-dimensional plane on a surface thereof;

a plurality of photoelectric converter elements arranged in the two-dimensional plane in a matrix configuration having rows and columns;

an array of color filters including a plurality of units, each unit consisting of two adjacent photoelectric converter element rows, said units being repeatedly and contiguously arranged in said array in a column direction, in which one color filter of the array is formed over each of said photoelectric converter elements, wherein, the first row of each unit has a first color layout of color filters arranged in a row direction and the second row of each unit has a second color layout of color filters arranged in a the row direction, said second color layout being different from said first color layout;

one vertical charge transfer channel region formed in said semiconductor substrate for each of the columns of said photoelectric converter elements, adjacent to said each column;

a plurality of vertical charge transfer electrodes in which two vertical charge transfer electrodes are disposed over said vertical charge transfer channel regions for each of the rows of said photoelectric converter elements; and

a drive circuit capable of applying readout pulse voltages to said vertical charge transfer electrodes corresponding to said photoelectric converter element row having said first color layout in a first unit and to

said vertical charge transfer electrodes corresponding to said photoelectric converter element row having said second color layout in a second unit, said second unit being at a position apart from said first unit by two units in the column direction.

12. (Original) The solid-state image pickup device according to claim 11, further comprising a variable barrier formed in said semiconductor substrate below said photoelectric converter elements,

said variable barrier being capable of modulating an amount of electric charge accumulable in each of said photoelectric converter elements.

Claims 13 - 14. (Cancelled)

15. (Currently Amended) A method of controlling a solid-state image pickup device, comprising a semiconductor substrate having a two-dimensional plane on a surface thereof;

a plurality of photoelectric converter elements arranged in the two-dimensional plane in a matrix configuration having rows and columns;

an array of color filters including a plurality of units, each unit consisting of two adjacent photoelectric converter element rows, said units being repeatedly and contiguously arranged in said array in a column direction, in which one color filter of the array is formed over each of said photoelectric converter elements, wherein, the first row of each unit has a first color layout of color filters arranged in a row direction and the second row of each unit has a second color layout of color filters arranged in the row direction, said second color layout being different from said first color layout;

one vertical charge transfer channel region formed in said semiconductor substrate for each of the columns of said photoelectric converter elements, adjacent to said each column;

a plurality of vertical charge transfer electrodes in which two vertical charge transfer electrodes are disposed over said vertical charge transfer channel regions for each of the rows of said photoelectric converter elements; and

a drive circuit capable of applying readout pulse voltages to said vertical charge transfer electrodes corresponding to said photoelectric converter element row having said first color layout in a first unit and to

said vertical charge transfer electrodes corresponding to said photoelectric converter element row having said second color layout in a second unit, said photoelectric converter element row having said second color layout in ~~rows of said second unit being at positions~~ a position apart from said photoelectric converter element row having said first color layout in said first unit ~~respective photoelectric converter element rows of said first unit~~ by four photoelectric converter element rows in the column direction;

said method comprising the steps of:

a) classifying said vertical charge transfer electrodes into sets each of which includes 16 vertical charge transfer electrodes as one set, said 16 vertical charge transfer electrodes ranging from a first vertical charge transfer electrode to a 16th vertical charge transfer electrode succeeding one after another, and

applying readout pulse voltages to

said vertical charge transfer electrodes belonging to said photoelectric converter element row having said first color layout of said first unit, said first unit being selected from each said set and to

said vertical charge transfer electrodes belonging to said photoelectric converter element row having said second color layout different from said first color layout of said second unit, the photoelectric converter element rows having said second color layout of said second unit being formed in positions spaced apart from positions of the ~~respective~~ photoelectric converter element rows having said first color layout of said first unit by four photoelectric converter element rows in the column direction;

b) transferring the signal charge read out by said step a) through said vertical charge transfer channel regions for four photoelectric converter element rows in the column direction;

c) applying readout pulse voltages to said vertical charge transfer electrodes belonging to said photoelectric converter element rows of said first and second units, which are not used to read the electric charge therefrom in said step a); and

d) transferring the electric charge read out in said step c) and the electric charge read out in said step a) in said vertical charge transfer channel regions.

16. (Original) The method of controlling a solid-state image pickup device according to claim 15, wherein said device further comprises a variable barrier formed in said semiconductor substrate, said variable barrier being capable of modulating an amount of electric charge accumulable in each of said photoelectric converter elements, said method further comprising the step of

x) modulating by said variable barrier an amount of electric charge accumulable in each of said photoelectric converter elements to one half of an original amount thereof before said step a).

Claims 17 – 18. (Cancelled)